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EFFECT OF FLOODS ON TRANSPORTATION

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HYDRAULICS DIVISION

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EFFECT OF FLOODS ON TRANSPORTATION

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SYNOPSIS

The effect of floods on transportation is examined and evaluated as regards railroads, highways, pipelines, air fields and navigable streams. Emphasis is placed upon the flood effect on railroads because of the primary position that they occupy in transportation. The paper also points out that many of the early railroads located their lines in the river valleys and have, as a result, encountered more difficulties with floods than their competitors in transportation.

The loss of revenue, increased operating costs and the cost of restora tion due to flood damage on railroads are discussed. Some typical examples are presented, showing the extent of damage and restoration costs sustained by the Missouri Pacific Railroad during the Spring floods of 1950 and 1951.

The progress that the Missouri Pacific, collaborating with the United States Government, has made in protecting its traffic route between East St. Louis and Thebes, Illinois from possible floods, is also described.

The advantages of flood protection for transportation and industries are illustrated by the situation in the Mississippi Valley.

INTRODUCTION

Mankind has always been plagued by floods. Homes are inundated; crops are ruined; lives are lost and the normal daily pattern of life is disrupted to such a degree that resumption seems impossible, or at least futile.

All forms of transportation are more or less adversely affected by floods - railroads, highways, pipelines, a few air fields and even water borne commerce. The interruptions to normal operations are reflected in delays and increased costs that are extended into the national economy.

Railroads

The railroad industry, perhaps more than any other means of passenger and commodity transportation, is adversely affected by floods. A flood which disrupts the normal operation and traffic pattern of a railroad not only causes delay and discomfort to its passengers, but delays all commodities and endangers perishable freight being transported as well.

Any examination of the effect of floods on railroads must be coupled with a brief analysis of the underlying causes. There are two important reasons why many of the early railroads built their lines in the river valleys and through the years have encountered more difficulties with floods than their competitors in transportation.

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1. Chief Engineer System, Missouri Pacific Lines, St. Louis, Mo.

When industry first started its growth it selected the river valleys for its sites, the decision to do so being predicated on the availability of a means of transporting its goods. The railroads in order to serve these industries found it necessary, or at least very desirable, to locate their lines in the valleys.

The economics of railroad transportation require comparatively light and easy gradients. It is only logical that early railroad locations followed the valleys wherever practicable in order to obtain light gradients at minimum expense.

It is readily apparent that many railroads have located in the river valleys as a means of not only obtaining light gradients but to secure the trade of existing industries as well, and it is this early choice of location that now makes them the main target of floods.

With the advent of dieselization the nation's railroads were faced with another flood problem. While steam locomotives have been able to traverse flooded reaches with just enough clearance above the water to clear the fire box, the Diesel locomotive, with its traction motors below the axle level, is usually restricted in its movements to a water level of not more than two or three inches above the top of rail and then at a speed of not to exceed two miles per hour.

In many instances where there is available only one rail artery through a flooded area the affected railroads are forced to disband completely their operation through the area and make other arrangements which not only cause delay but are extremely expensive as well. They may be forced to take their traffic in circuitous routes over other railroads and pay the cooperating road the prevailing rates for allowing them to do so. If this recourse is not available, their situation can result in even greater losses. Passengers so involved with the delay and discomfort which so often accompany floods, are apt to choose some other means of transportation in the future. Perishables delayed are apt to lose their market value and the railroad loses prestige and often as not the shipper as well.

In addition to the loss of revenue that results from their inability to handle the commerce of the nation because of a flood, railroads experience another revenue loss over which they have absolutely no control. This latter loss is the reduction in car loadings due to the flood's effect on shippers, which include manufacturers, processors and farmers.

The railroads' revenue loss from floods is therefore twofold. In one case the producers are unable to ship the commodities because of reduced production, and in the other, the railroads are unable to transport the goods due to their lines having been flooded.

When flood waters overflow the track the ballast is often washed away, allowing the track to be carried off the embankment. If the current is very strong the embankment itself may be at least partially carried away. To rebuild the grade, recover the track and apply new ballast after water recedes usually requires several days and sometimes weeks. Cost of restoration may be as much as sixty thousand dollars per mile, and more if any bridges have been seriously damaged. The cost to restore a railroad bridge at Laredo, Texas, carried away by the Rio Grande flood of July, 1954, is not available, but the time required to restore traffic over a temporary structure was about six weeks.

Typical examples of the extent of the damages and restoration costs sustained by the Missouri Pacific during the Spring floods of 1950 and 1951 are shown in Table 1. The table depicts but a few of the total number of

occurrences for those years, but it gives representative pictures covering the effects of washouts.

In this brief glimpse of overflow damages, nine rivers are involved, ranging in size from mere streams to the mighty Missouri. There is also quite a difference in the amount of damage involved at the several locations. In one instance, on the Marias des Cygnes River at Osawatomie, Kansas, while the track was inundated to a depth of almost 15 feet, the only track damage in the affected length of 1.8 miles was the washing and fouling of ballast. The traffic was suspended for six days due only to water being over the track, and during the suspension no detour lines were available. The cost to restore the track to its original condition was $3500. In another instance, on the Neosho River, over 2.5 miles of track were involved. All the ballast was washed away, the track itself was overturned off the dump and there were embankment washes most of the total distance with holes up to twelve feet deep. Traffic was suspended for ten days and during the suspension another railroad in the vicinity had to be used. The cost to restore the track to its original condition was $147,500, and the increased cost of operation due to routing traffic over the other line amounted to almost $4,000.

The magnitude of the damage and restoration costs that can be experienced at bridges is illustrated in the table by the item of the Missouri Pacific's bridge over the Arkansas River at Yancopin, Arkansas. A flood runout during July, 1950 was attended by swift currents and heavy eddy action and resulted in the undermining and loss of the trestle approach at the south end of the steel span. Continuous emergency measures were required to control erosion and recession of the south bank and further loss of the approach trestle. Traffic was suspended eighty-six days and during the suspension other Missouri Pacific lines were available for detour purposes. The cost to restore the bridge to service was $847,300 which included the installation of a 300 foot truss span replacing the trestle approach

Six other examples are listed in Table 1 previously mentioned.

The total cost of repairing storm and high water damage on the Missouri Pacific in 1951 was $3,255,200. This amounted to 1.4 percent of the total operating revenue for that year and gave the 1951 floods the dubious distinction of being the most expensive ever sustained by the Missouri Pacific. The damage experienced during the floods of 1927 had previously been the most expensive, with restoration costs amounting to $2,377,200, or approximately two percent of the total operating revenue for that year.

The total cost resulting from a flood overflow is comprised of the cost of restoration, the increased cost of operation, damage to commodities due to delayed delivery or spoilage and direct revenue losses.

In backwater areas, damage is usually not great as far as any major disturbance of the roadbed or embankment is concerned. However, whenever high water overtops the track, the ballast is always fouled by sediment and, although operations may be resumed as soon as the water recedes, considerable time and expenditure are involved in cleaning or replacing the fouled ballast.

Sites at which floods are expected can be protected and track damage held to a minimum by applying selected ballast or by the application of rip rap on the downstream shoulder. The installation of flood anchors to help secure the track will also minimize damage.

To prevent the financial losses incurred by a flood and to attract more traffic, railroads strive to eliminate, as best they can, the trouble spots on their primary lines by getting the railroad away from the possible flood

points by raising the grade, or, if the situation warrants, completely relocating the line so that it will be above the probable flood plane. On less important lines, flood anchors, rip rap and additional waterway openings are used to minimize damage.

In line with this policy of overflow prevention, railroads enter wholeheartedly, as a rule, with Federal and State governments into any arrangement that will improve the dependability of their lines.

As an example of cooperation, in the flood control program along the Mississippi River from East St. Louis to Thebes, Illinois, the Federal Government has for several years been reconstructing existing levees and constructing new levees for the protection of some 233,000 acres of land under the Flood Control Act of Congress approved June 28, 1938. Under agreement between the Government and the Missouri Pacific Railroad which follows the valley, the following work, which is shown on exhibit figure 1, has been carried out or is well advanced: 1. Levees have been constructed from river mile 47 to 99 above the mouth of the Ohio River, and from river mile 122 to 176, a total distance of 106 miles, with flank levees tied back into high ground along the principal tributaries. 2. At the location of 6 flank levee crossings the track is raised over the levees, and at two other crossings water proof passages were constructed through the levees and across the floodway. These passages consist in one instance of a steel trough, 6 feet 11 inches deep, which rests on a double track deck girder bridge. The trough encases the two tracks that pass through it and extends into the levee on each side of Prairie du Pont Creek by using concrete closure walls.

At the other point a multiple concrete box has been constructed, consisting of five barrels, each 11 ft. by 9 ft. 8 inches, extending under four tracks, with headwalls extending 13 ft. above the track and wing walls tying into the levee on each side of Prairie du Rocher Creek. The cost of the above work is borne by the Government except for some minor items absorbed by the railroad. The Railroad also has paid some heavy assessments in the sponsoring levee districts to cover the cost of rights of way for levees and other items to meet Government requirements. 3. In the twenty mile reach opposite river mile 99 to mile 122 the river lies close to the Illinois bluffs and no levee is provided. In this area the Railroad has completed 17 of the 20 miles of track to be raised or relocated at its own expense, at an elevation above the project flood plane, averaging approximately 10 feet above the old grade.

Total cost to the Railroad will be $5,555,000. Upon completion of this project it is expected that this line will be free from interruptions to service due to overflow.

Highways

Highway traffic, be it passenger or commodity, is usually not so restricted in its movements as railroad traffic. Seldom is the case where there is only one access road through a possible flood route. Usually there is a main arterial highway with several branches forming a pattern over which traffic can move continuously during flood periods, although at increased distances involving delays and greater costs.

There is usually less damage to highways. Gravel roads may be badly damaged but restoration is not so costly. Paved roads very often are intact after severe overflows except for wash of the downstream shoulder, which is readily restored.

In more severe flooding the paving may be undermined and practically destroyed and any bridges or culverts involved may be damaged to such an extent that passage over them is impossible. The resulting cost of restoration and delays to traffic by reason of detours is comparable to the heaviest damage sustained by railroads.

Flooded conditions on highways have resulted in numerous occasions of loss of life and many narrow escapes. There has also been some loss of life due to flooded conditions on the railroads, but not as great as on the highways. One reason for this is that there is more safety consciousness on the railroads than there is by the users of the highways.

Industry and the general public demand dependable transportation. The railroad or highway that is relatively free from interruption to traffic by reason of overflow will be more likely to attract and hold the traffic.

Pipelines

Pipelines are usually affected by floods only at such points where river crossings are made. The increased velocity of the current and resulting bottom scour that accompany floods often produce pressures and conditions that pipelines cannot withstand. The expenditures by the pipeline companies to protect these underwater crossings have not in all cases proven justifiable from an operating standpoint because of recurring pipe failures caused by floods. In order to avoid this installation and maintenance expense and to insure dependable operation, many pipeline companies are resorting to suspension spans to cross troublesome streams.

Air Fields

Of course the airways are not affected by floods, but there have been a few instances of air fields being covered by flood waters, resulting in interrupted service. For example, in May, 1952, newspaper reports described the the interruption of air service to St. Joseph, Missouri, Fort Leavenworth, Kansas, and Kansas City, Kansas due to flooded condition of airports at these cities. The better located air fields are above high water or have adequate levee protection, but the effect of floods often precludes the selection of an otherwise more favorable site.

Navigation

Even inland navigation is adversely affected by flood flows. Boats and tows may move downstream a little faster, but this is more than offset by the increased difficulty of making any headway upstream, and heavy drift is frequently a hazard to operation in either direction.

Another difficulty in navigation is with marine installations such as docks, wharves and landing or incline facilities for railroad car ferries. Although the majority of traffic consists of movements up or downstream, a sizeable proportion is comprised of the cross movement of rail and highway vehicular traffic handled by ferries.

These marine facilities are designed to accommodate the ordinary varying river stages, but major floods often produce stages above the ordinarily prudent design with serious effects on the loading and unloading schedules.

One effect of floods on transportation can be illustrated by an example of the result of flood protection afforded East St. Louis, Illinois and surround-

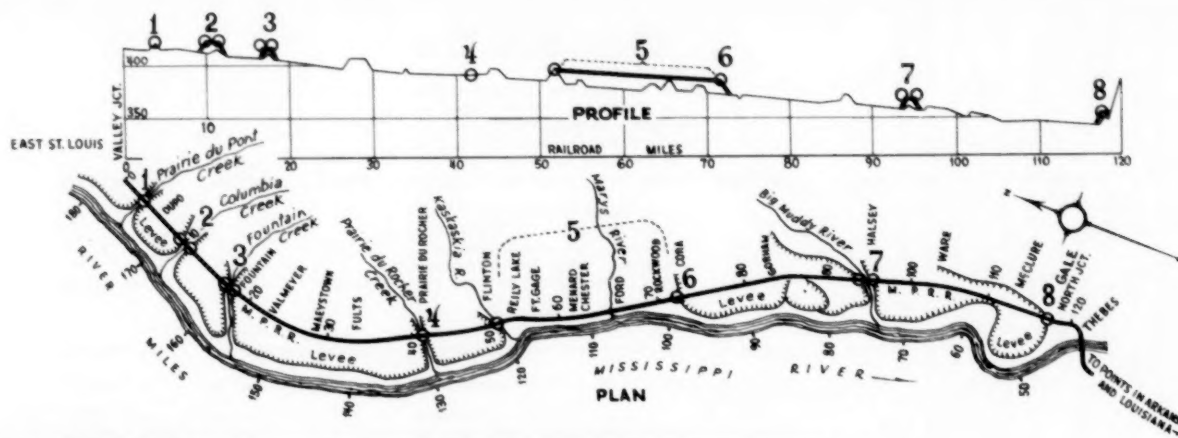
surrounding territory. The area has long been covered by a network of railroads reaching into St. Louis. Industry was at first cautious of locating in this region because of periodic overflows from the Mississippi River, but as soon as adequate levee protection was provided, the area was covered with many great industries attracted by the transportation facilities, level terrain and an adequate water supply. With completion of the levee program below East St. Louis to Thebes, Illinois, now well advanced, it may be anticipated that this area, served by highways, barge lines and two railroads, will become more attractive to industry.

The present levee system on the lower Mississippi, an alluvial valley second to none, assures dependable transportation and affords industry protection from overflow. It is probably this inducement that is causing the rapid growth of cities and industrial expansion in the valley. This area that was once retarded in its industrial growth by possible floods now finds its economic position enhanced by their absence.

TABLE "1"

TYPICAL FLOODS ON THE MISSOURI PACIFIC RAILROAD DURING 1950 AND 1951

Location	Stream	Affected Length	Nature of Damage	Restoration Cost	Traffic Suspended	Detour Used During Suspension
Sandy Hook, Mo.	Missouri River	2.5 Miles	Ballast wash; embankment cut out 10 to 20 ft. deep.	$ 15,000	18 days	MP main line via Sedalia Subdivn.
Osawatomie, Ks.	Marais des Cygnes Riv.	1.8 Miles	Flood water overtopped track to depth of 14.7 ft., washing out ballast various locations.	$ 3,500	6 days	None
Kansas City, Ks. and Mo.	Kansas River	50 Miles of main, yard & industry tracks	Tracks overflowed and washed out; embankments cut out to depths of 10 ft. in spots; buildings and facilities damaged; silt and debris deposited by flood waters hampered restoration of services.	$775,400	8 days	None
Waterville, Ks.	Big Blue River	1.0 Miles	Ballast wash; embankment damaged.	$ 5,000	10 days	Buses & trucks
Solomon Rapids, Kans.	Solomon River	0.5 Miles	Ballast wash; embankment badly damaged.	$ 6,000	4 days	None
Padonia, Ks.	Walnut Cr.	0.5 Miles	Embankment cut 5 to 10 ft. deep.	$ 10,000	2 days	Over other R.R.
Toronto, Ks.	Verdigris River	0.6 Miles	Ballast; riprap protection and most of embankment washed away. Track overturned off dump.	$ 35,000	4 days	Various
Leroy, Ks.	Neosho River	2.5 Miles	All ballast washed away, track overturned off dump. Embankment washed most of distance with holes up to 12 ft. deep. Signal interlocker damaged.	$147,500	10 days	Over other R.R.
Yancopin, Ark.	Arkansas River	Bridge No. 87	Flood runout attended by swift currents and heavy eddy action resulted in undermining and loss of trestle approach at south end of steel spans. Necessary to take emergency measures to avoid further loss of bank and south approach trestle and replace trestle with 300' truss span.	$847,300	86 days	MP main line via Little Rock - Poplar Bluff



ITEM	RAILROAD MILE	RIVER MILE	DESCRIPTION OF WORK
1	3.8	176.0	Provide waterproof metal deck and sidewalls, Bridges 3 and 3A, with concrete floodwalls at ends tied into levees to eliminate track raise
2	10.4 TO 11.3	167.2 TO 168.1	Raise tracks and Bridges 11 and 11A a maximum of ten feet at Columbia Creek
3	17.5	160.0	Raise tracks approximately six feet over levees at Fountain Creek Rebuild and alter Bridges 23, 23A, 24 and 24A
4	41.5	131.0	Provide concrete culvert for relocated Prairie du Rocher Creek with track levees connecting flank levees over culvert to eliminate track raise
5	51.8 TO 71.7	122.0 TO 99.0	Between Kaskaskia River and Cora raise track 0 to 15 feet to provide new base of rail grade above future designed flood plane, including altering and raising bridges
6	71.7	99.0	Raise tracks south of levee at Cora approximately 11 feet
7	94.4	74.0	Raise tracks 12 feet over levees at Big Muddy River Rebuild Bridges 129, 130 and 131
8	117.7 TO 118.5	47.0	Raise tracks north of levee at Gale approximately four feet Raise tracks and Bridges 146 and 146A south of levee to level grade

FIGURE 1

MISSOURI PACIFIC R.R.

FLOOD PROTECTION

BETWEEN

EAST ST. LOUIS AND THEBES, ILL.

GENERAL DESCRIPTION OF WORK

OFFICE OF CHIEF ENGINEER SYSTEM, ST. LOUIS, MO.

NOVEMBER, 1954

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c. Discussion of several papers, grouped by Divisions.

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